Citation:

Buijsse B, Feskens EJ, Schulze MB, Forouhi NG, Wareham NJ, Sharp S, Palli D, Tognon G, Halkjaer J, Tjønneland A, Jakobsen MU, Overvad K, van der A DL, Du H, Sørensen TI, Boeing H. Fruit and vegetable intakes and subsequent changes in body weight in European populations: results from the project on Diet, Obesity, and Genes (DiOGenes). *Am J Clin Nutr.* 2009 Jul;90(1):202-9. Epub 2009 May 20.

PubMed ID: 19458016

Study Design:

Prospective Cohort Study

Class:

B - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To assess whether fruit and vegetable intake is associated with subsequent changes in body weight within a multicenter European prospective cohort study.

Inclusion Criteria:

- Participants of the European Prospective Investigation into Cancer and Nutrition

Exclusion Criteria:

- Women who were pregnant at either baseline or follow-up (n = 133)
- Participants who provided no information on baseline diet (n = 113)
- Participants who were in the center-specific top and bottom 1% of the distribution of the ratio of reported energy intake over estimated energy requirement (n = 1803)
- Participants who had not information on anthropometric measures at baseline (n = 964)
- Participants who had no follow-up information on anthropometric measures or follow-up time (n = 1058)
- Participants with unrealistic anthropometric measures at either baseline or follow-up (n = 165)
- Participants who reported extreme changes in annual weight or waist circumference (n = 166)
- Participants with baseline cardiovascular disease, diabetes mellitus or cancer (n = 8512)

Description of Study Protocol:

Recruitment

Data used were from 89,432 men and women from 5 countries participating in the European Prospective Investigation into Cancer and Nutrition (EPIC).

Design: Prospective Cohort Study

Blinding used (if applicable): not applicable

Intervention (if applicable): not applicable

Statistical Analysis

- The association between fruit and vegetable intake and weight change after a mean follow-up of 6.5 years was assessed by linear regression
- Polytomous logistic regression was used to evaluate whether fruit and vegetable intake relates to weight gain, weight loss, or both
- Odds ratios and their 95% confidence intervals of weight gain and weight loss were calculated per 100-g intake of fruit and vegetables per day
- Assessed the effect of excluding participants with incident cardiovascular diseases, diabetes or cancer during follow-up as well as those with missing data on covariates

Data Collection Summary:

Timing of Measurements

Habitual dietary intake assessed at baseline. Height and weight measured at baseline, and measured or self-reported at follow-up. Subjects followed for a mean of 6.5 years.

Dependent Variables

- Body height and weight measured at baseline with participants wearing no shoes and light clothing.
- Anthropometric measurements performed by trained staff using same protocol in the United Kingdom and Doetinchem
- Anthropometric measurements self-reported in Italy, Amsterdam/Maastricht, Germany and Denmark

Independent Variables

- Fruit and vegetable intake; all fruits and vegetables were included except potatoes, olives, fruit and vegetable juices, and tomato sauces
- Habitual dietary intakes over the past year were assessed by means of country-specific food-frequency questionnaires
- In a random sample of 8% of each EPIC cohort, dietary intakes were also assessed with a highly standardized 24-hour recall by using EPIC-SOFT

Control Variables

- Age
- Sex
- Cohort
- Duration of follow-up
- Baseline weight
- Occupational and leisure-time physical activity assessed by questionnaire

- Smoking habits collected by questionnaire
- Highest achieved education
- Alcohol consumption
- Prevalence and incidence of diabetes, cardiovascular disease, and cancer assessed by questionnaire, interview and/or hospital discharge information
- In women, postmenopausal status and postmenopausal hormone use
- Total energy intake

Description of Actual Data Sample:

Initial N: 146,543 initial participants who attended baseline examination. 102,346 participated at follow-up.

Attrition (final N): 89,432 men and women participating in EPIC, after application of exclusion criteria. 52,307 were women (58%).

- 39,909 in Denmark
- 16,307 in Germany
- 12,808 in the United Kingdom
- 9,297 in Italy
- 4,200 in Doetinchem, Netherlands
- 6,911 in Amsterdam/Maastricht, Netherlands

Age: means for all quintiles not reported; mean ~53 years

Ethnicity: not specified

Other relevant demographics:

Anthropometrics

Location: 5 European countries, as above

Summary of Results:

Key Findings:

- Men and women gained weight over time in all cohorts, with an overall mean weight change of 330 grams per year
- Fruit and vegetable intake was weakly inversely associated with weight change
- Per 100-g intake of fruit and vegetables, weight change was -14 grams per year (95% confidence interval: -19 to -9 g/y).
- When weight gain and loss were analyzed separately per 100-g intake of fruits and vegetables in a combined model, the odds ratios (95% confidence intervals) were 0.97 (0.95 to 0.98) for weight gain >0.5 and <1 kg/year, 0.94 (0.92 to 0.96) for weight gain >1 kg/year, and 0.97 (0.95 to 0.99) for weight loss >0.5 kg/year.

Variables	Mean Fruit and Vegetable Intake (g/y)	Weight Change (95% CI)	P for Interaction
Sex			0.02

Men (n = 37,125)	358	-7 (-15, 1)	
Women (n = 52,307)	333	-12 (-18, -5)	
Baseline Age			0.05
<60 years (n = 69,353)	346	-15 (-21, -9)	
>60 years (n = 20,079)	354	-13 (-25, -1)	
Follow-up Duration			0.01
<5.5 years (n = 43,235)	329	-11 (-16, -5)	
>5.5 years (n = 46,197)	368	-17 (-25, -9)	
Baseline BMI			<0.0001
<25 kg/m^2 (n = 42,819)	351	-15 (-22, -9)	
>25 kg/m^2 (n = 46,613)	345	-14 (-22, -6)	
Smoking Behavior			<0.0001
Nonsmokers (n = 63,675)	387	-13 (-19, -7)	
Stable smokers (n = 16,837)	288	-5 (-17, 6)	
Stopped smokers (n = 5916)	306	-37 (-58, -15)	
Started smokers (n = 1564)	356	-4 (-43, 35)	

Other Findings

- Mean duration of follow-up ranged from 3.7 years in the United Kingdom to 10.0 years in Amsterdam/Maastricht
- Median intake of fruit and vegetables was 324 grams per day in men and 377 grams per day in women
- Those with higher fruit and vegetable intakes were less likely to smoke, had lower intakes of alcohol, and higher intakes of calories from carbohydrates
- Women with high fruit and vegetable intakes were more likely to engage in moderate physical activity
- In those who stopped smoking during follow-up, this value was -37 grams per year (95% confidence interval: -58 to -15 g/y, P for interaction < 0.0001).
- In those who stopped smoking during follow-up, the odds ratios (95% confidence intervals) were 0.93 (0.88 to 0.99) for weight gain >0.5 and <1 kg/year, 0.87 (0.81 to 0.92) for weight gain >1 kg/year, and 0.97 (0.88 to 1.07) for weight loss >0.5 kg/year (P for interaction < 0.0001).

Author Conclusion:

In conclusion, although fruit and vegetable intake was weakly related with weight change in the present study, the findings have public health relevance and support initiatives to increase the intake of fruit and vegetables. Our findings are also of relevance to the massive smoking cessation initiatives in Europe, which suggest that adding a fruit and vegetable component to programs directed at stopping cigarette smoking may help to limit weight gain in those who stop smoking.

Reviewer Comments:

Height and weight measured at baseline, and measured or self-reported at follow-up, depending on country, and different protocols were used. Only 3.7 years of follow-up in the United Kingdom cohort. Fruit and vegetable intake only measured at baseline.

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions		
1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions		
1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes

2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	**Were study groups comparable?**	N/A
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	Yes
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	N/A
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	Yes
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	Yes
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	Yes
4.1.	Were follow-up methods described and the same for all groups?	Yes
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	N/A
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	N/A

5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	N/A
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	N/A
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	Yes
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes

8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes